T. Humphries, J. Winn and A. Faridani, Superiorized algorithm for reconstruction of CT images from sparse-view and limited-angle polyenergetic data, *Physics in Medicine and Biology,* Vol. 62 (**2017**), 6762.
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Abstract

Recent work in CT imaging has seen increased interest in the use of total variation (TV) and related penalties to regularize problems involving reconstruction from undersampled or incomplete data. Superiorization is a recently proposed heuristic which provides an automatic procedure to "superiorize" an iterative reconstruction algorithm with respect to a chosen objective function, such as TV. Under certain conditions, the superiorized algorithm is guaranteed to find a solution that is as satisfactory as any found by the original algorithm with respect to satisfying the constraints of the problem; this solution is also expected to be superior with respect to the chosen objective.

Most work on superiorization has used reconstruction algorithms which assume a linear measurement model, which in the case of CT corresponds to data generated from a monoenergetic X-ray beam. Many CT systems generate X-rays from a polyenergetic spectrum, however, in which the measured data represent an integral of object attenuation over all energies in the spectrum. This inconsistency with the linear model produces the well-known beam hardening artifacts, which impair analysis of CT images.

In this work we superiorize an iterative algorithm for reconstruction from polyenergetic data, using both TV and an anisotropic TV (ATV) penalty. We apply the superiorized algorithm in numerical phantom experiments modeling both sparse-view and limited-angle scenarios. In our experiments, the superiorized algorithm successfully finds solutions which are as constraints-compatible as those found by the original algorithm, with significantly reduced TV and ATV values. The superiorized algorithm thus produces images with greatly reduced sparse-view and limited angle artifacts, which are also largely free of the beam hardening artifacts that would be present if a superiorized version of a monoenergetic algorithm were used.